A Brief Introduction to

The Comprehensive Utilization of the Yangtze River Basin

長江流域の総合的活用の概要

China Yangtze Power Co. Ltd

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1 Overview of the Yangtze River Basin

2 Comprehensive measures for the control of water resources in the Yangtze river basin

3 The effects of the Comprehensive Measures

Prospects for Integrated Dispatching

01 Overview of the Yangtze River Basin
長江流域の概要

1 Overview of the Yangtze River Basin

The Yangtze River is the largest river in China.

Known as the “Mother River of Chinese nation”, it provides water for about 400 million people in its basin, covering a drainage area of more than 1.8 million km2, breeding the splandid Chinese Civilization.

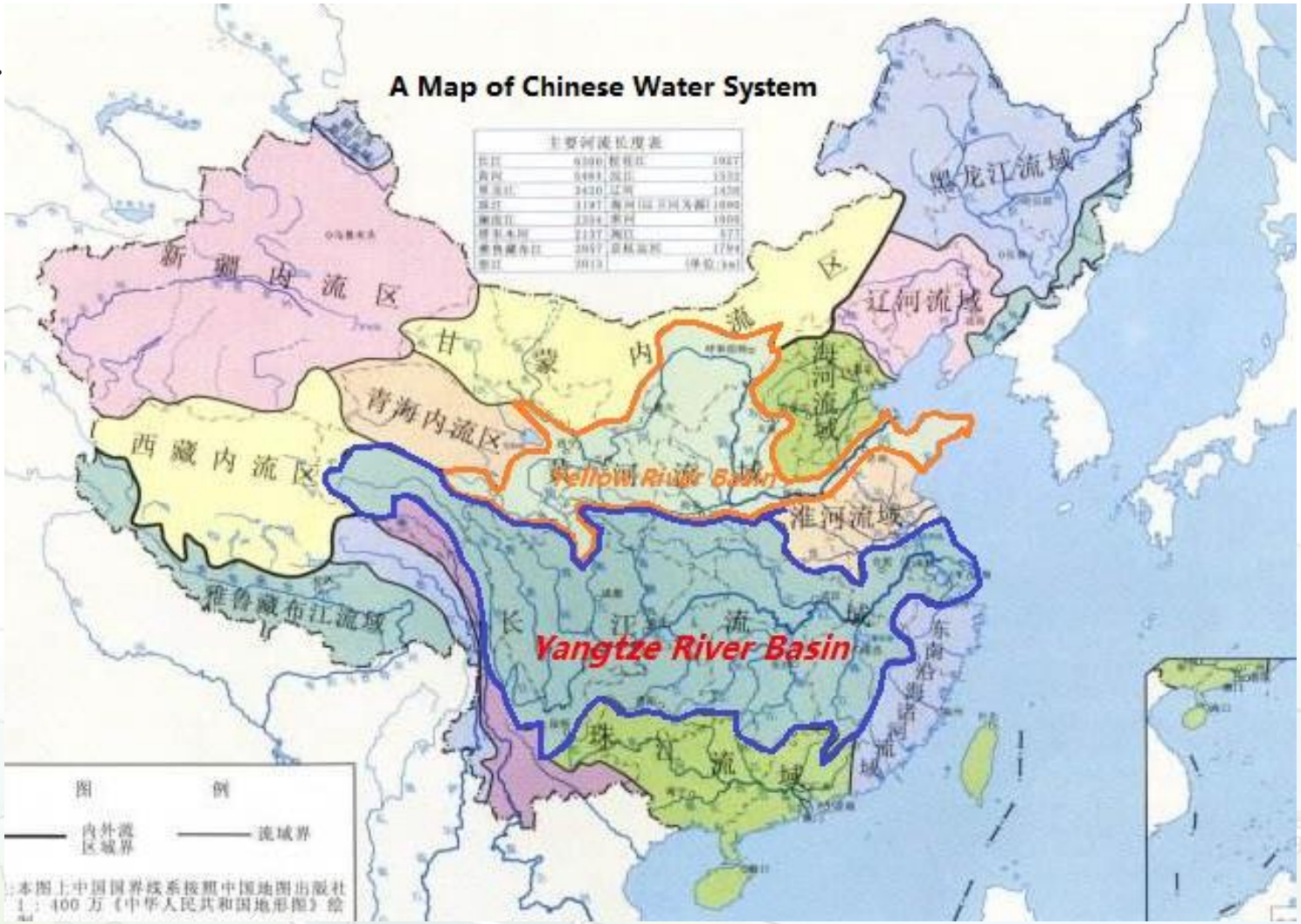
Length: 6363km

River Basin areas: 20%

Multi-year average flow: 956 billion m3, 36% of the total in China

GDP in the basin: 40%

Population: 35%



1 Overview of the Yangtze River Basin

But 5000 thousand-year civilization of the Chinese nation is also a history of flood or drought control.

The monsoon climate in the Yangtze River basin brings a plenty of rainwater in the flood season while almost no rain-fall during the dry season.

In recent 2100 years, the yantze river expeienced 214 times overflow flood disasters, once every decade on average.

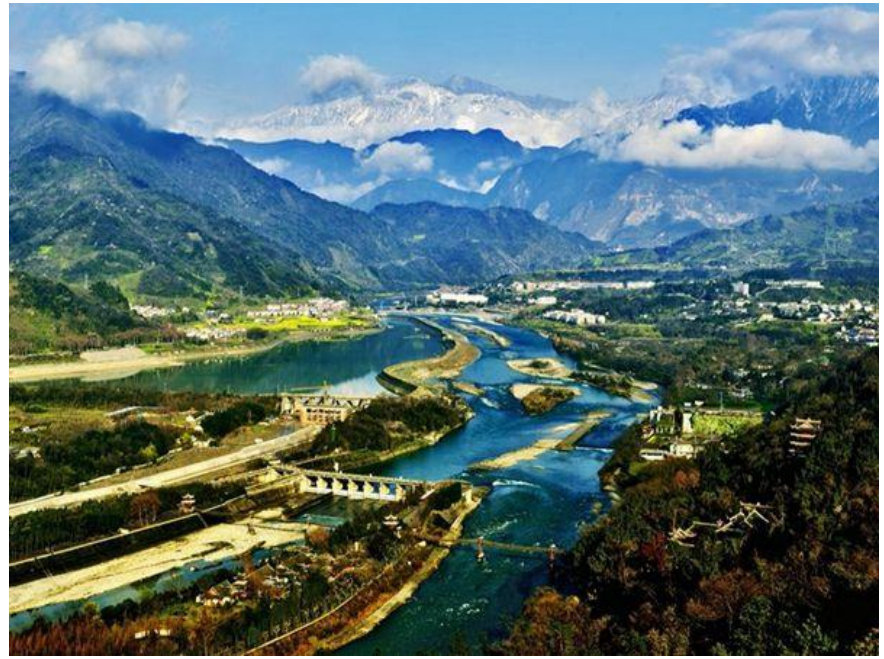
The interval between floods later became shorter. From 1499 to 1949 (450 years), the Middle Reach's Jingjiang Section flooded over its banks 186 times, once every two or three years on average.

In the 20th century, large floods struck the Chinese nation in 1931, 1935, 1949, 1954, 1998 and 1999.
Floods in 1931 and 1935, each lost lives of 140000
Flood in 1998, 1320 people died.

1 Overview of the Yangtze River Basin

With so many bitter flood stories, it has been always regarded as the most important matter for chinese administrator to build irrigation works and eliminate flood disasters.

In 256 BC of Qin Dynasty, the **Dujiangyan Irrigation Project** in Chengdu was built, turning the chengdu plain in “land of abundance”. This projects is even now still works well.



Since 1949, the Chinese government has carried out many large-scaled flood control projects in the basin.

In 1960s and 1970s, every winter 500000-700000 labors were organized to reinforce the Levees;

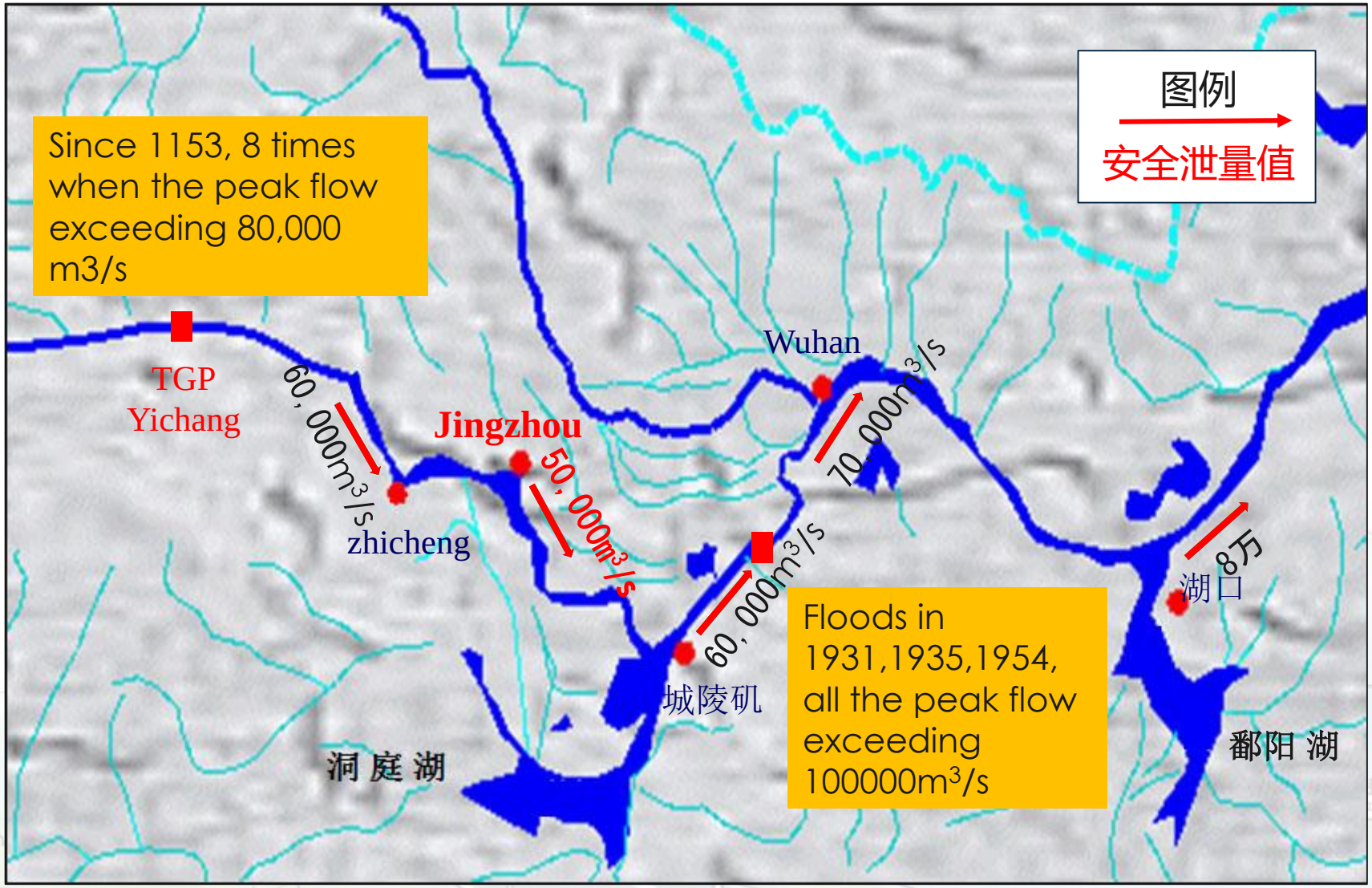
Some flood diversion and detention projects were built, as showed left the Jingjiang Diversion Works.

1 Overview of the Yangtze River Basin

But these measures cannot settle the basic contradictions that exist between **large flood peak** of the Yangtze River and the **small discharge** of the river channel, especially in the middle reach (as shown in right picture).

In order to relieve flood disaster , efforts must be made to build high dams and reservoirs in the upper reaches.

TGP is a good example, a good position for high dams, 95% of the huge floods in Jingzhou, or 61-80% in wuhan are from upper reaches.

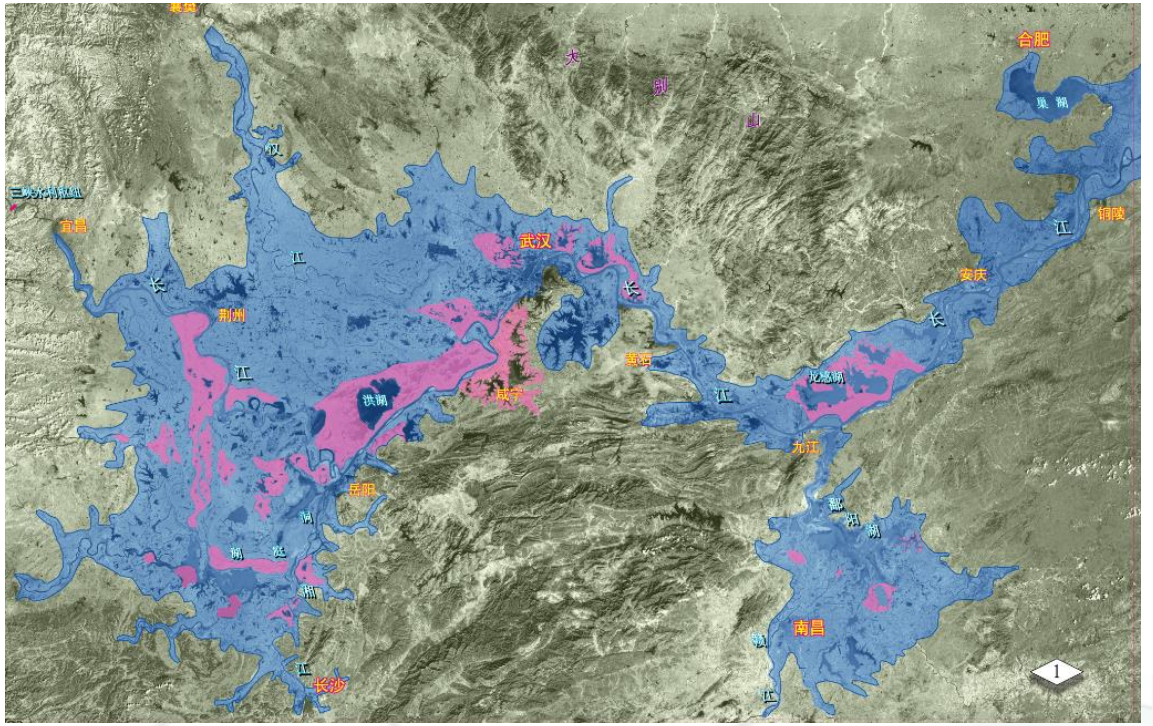


02 Comprehensive Engineering for the flood control
洪水対策総合工学

2 Comprehensive Engineering for the flood control

Up to now from early 1950s, Comprehensive flood management measures had been carried out, including:

- Rivers or lakes embankment reinforcement works of over 30,000km;
- Flood storage and detention areas: 42 with a volume of about 50 billion m3;
- Large resevoirs: 329, with a total flood control capacity of about 77 billion m3;
- Others: River dredging, returning farmlands to the lakes;



Of course, the TGP is the key egineering works, the project alone has a flood control capacity of 22.15 billion m3, accounting for 56 percent of the upper reaches of the Yangtze river.

2 Comprehensive Engineering for the flood control

Being of vital importance to the overall economic development and national security of China, the decision on the construction of TGP must be prudently made because of its tremendous scale, technical complexity, involving in a wide range of fields, and profound influence.

So, the TGP experienced a long-term argumentation process in excess of 40 years, starting from 1950s to April 3,1992, when the ***Resolution on the Construction of the Yangtze Three Gorges Project*** was passed in the 5th Session of the 7th National People's Congress.

When the TGP was laid aside, the Gezhouba Project was started on December 30, 1970.

In 1982, the first batch of generator units began commercial operation.

And it was completed in 1989.

The successful construction of GZB Project proved a good preparation for TGP in technology, experience, as well as personal training.

2 Comprehensive Engineering for the flood control

Starting in the 1950s, tens of thousands scientists and engineers participated in the feasibility study and design of the TGP. After 1980s, the Chinese Government mobilized a 14-panel-group consiting of 412 experts conducting further argumentation, with a conclusion: **TGP is both feasible in technology and reasonable in eomy. It's therefore better to construct TGP than not, and more advantages to construct it earliser than later.**

During the further argumentation, the Chinese government also engaged **China Yangtze Joint ture(CYJV)**, a Canadian corporation, to conduct a parallel argumentation study according to the internationally accepted atandard, with a conclusion : **The TGP, which promises to deliver immens benefits, is feasible technically, economically, and financially, and therefore recommend constructing the TGP as early as possible.**

Both groups focused on ten special topics:

1. Seismology, geology and hydropower-complex construction;	6. Ecology and environment;
2. Hydrology and flood control;	7. Comprehensive planning and water level;
3. Sediment removal and navigation;	8. Construction;
4. Power generation system and electro-mechanical devices;	9. Investment evaluation; and
5. People resettlement;	10. Comprehensive economic assessment.

2 Comprehensive Engineering for the flood control

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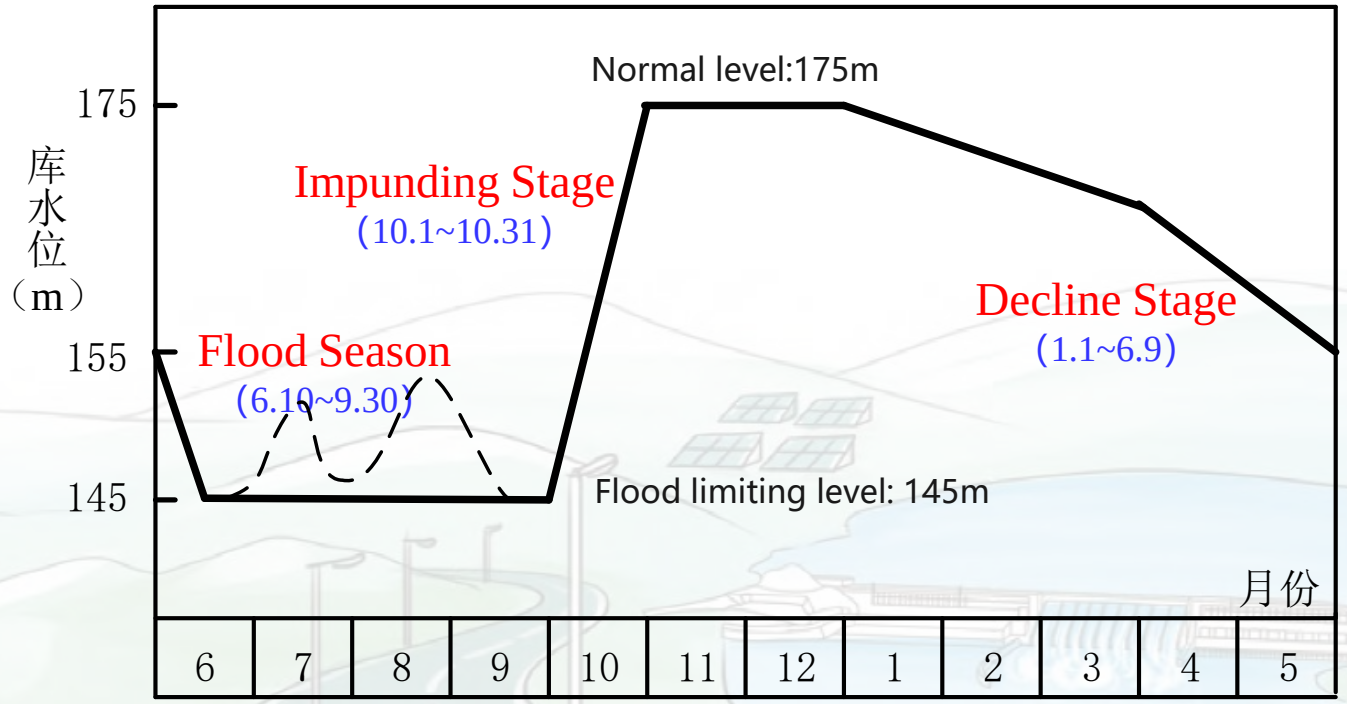
The initial flood control strategy after completion of the TGP:

During the flood season from June to September, the the water level of TG Reservoir is keeping flood limiting level of 145 m. The reservoir will begin to store water in early October, and gradually rise to 175 meters. For water replenishment as well as flood control purposes, it will fall to 145 meters in early June.

1. In case of a 100-year flood, after the TGP regulation, the corresponding flow of Zhicheng Station shall not exceed 56,700 m3/s and the water level in Shashi city shall not exceed 44.5 meters with no use of the flood diversion project;
2. In the case of a 1000-year catastrophe, the TG Reservoir regulation together with the Jingjiang flood diversion project and other flood retention measures, the water level in the Shashi City will not exceed 45.0 meters, to effectively avoid devastating disasters in Plains on both sides of the Jingjiang River.



Schematic diagram of annual water level of TG reservoir in preliminary design

2 Comprehensive Engineering for the flood control

The optimized flood control strategy of upstream multi-reservoir joint operation

After the TGP completion, a series of hydropower dams have been built, through joint management of upperstream reservoirs, the flood control strategy is becoming more and more flexible.

- The flood control function of the TG reservoir is enhanced by the simultaneous retention of the total amount of flood water in the upstream reservoirs to reduce the flood volume into the TG reservoir, increase the flood control ability of the TGP.
- Through the upstream reservoirs reducing the inflow flood peak of Three Gorges reservoir, the water level at the end of the TG reservoir can be reduced due to dynamic reservoir effect, and further increase the three gorges reservoir compensation capacity for chenglingji area, thus reduce the excess flood near chenglingji.

03 The effects of the Comprehensive Measures
総合施策の効果

3 The effects of the Comprehensive Measures

Flood Control

From 2010 to 2017, 41 flood control dispatches were carried out, with a total of 126.6 billion m^3 of flood storage, effectively ensuring flood control safety in the lower reaches of theYangtze River.

年 份 Time	最大洪峰及出现时间 Max inflow Peak and occurrence date (m^3/s)		最大下泄 Max discharge (m^3/s)	最大削峰量 peak clipping (m^3/s)	蓄洪次数 flood regulation times	总蓄洪量 flood storage (billion m^3)
2010	70,000	7/20	40,900	30,000	7	26.63
2011	46,500	9/21	29,100	25,500	5	18.76
2012	71,200	7/24	45,800	28,200	4	22.84
2013	49,000	7/21	35,000	14,000	5	11.84
2014	55,000	9/20	45,000	22,900	10	17.51
2015	39,000	7/1	31,000	7,400	4	8.85
2016	50,000	7/1	31,000	19,000	3	9.78
2017	31,000	8/27	19,000	12,000	3	10.36

3 The effects of the Comprehensive Measures

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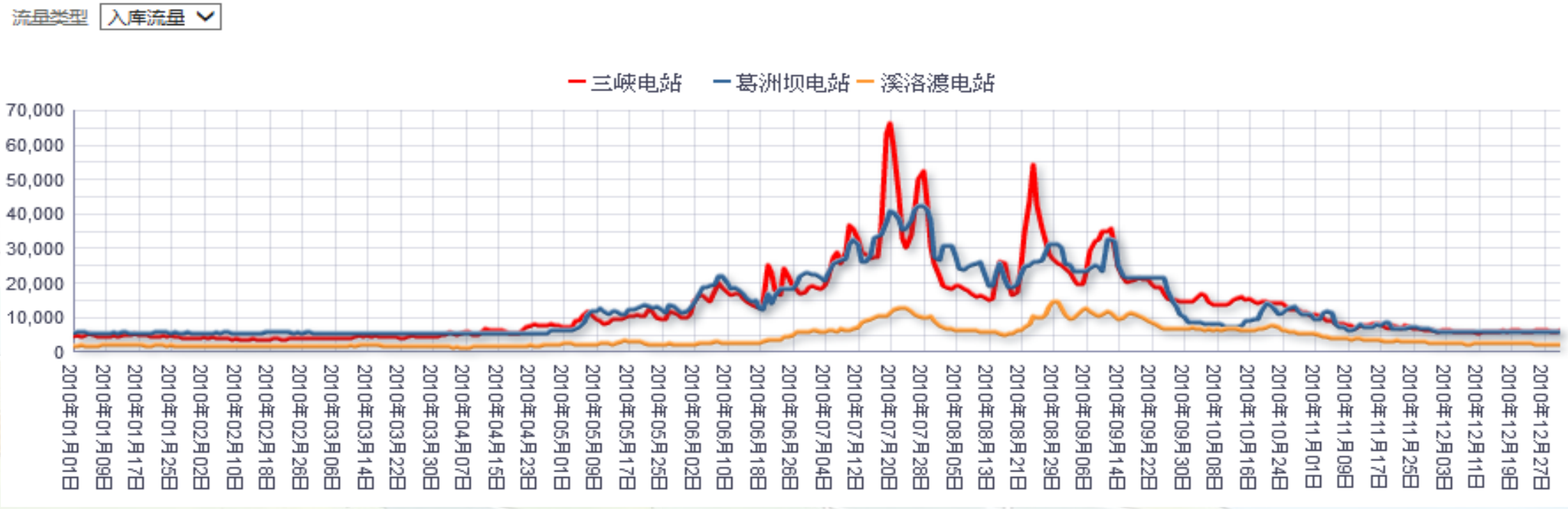
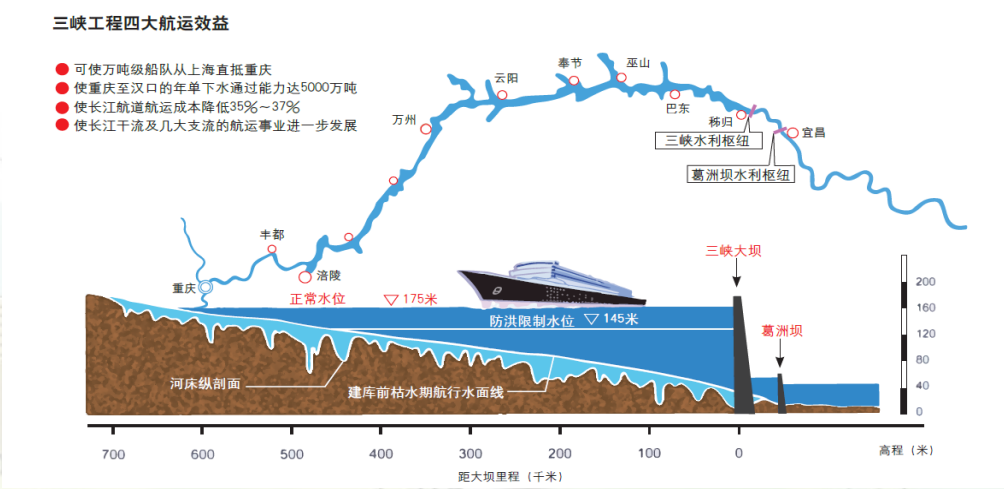
Flood Control

On July 20,2010, the Three Gorges Project faced its first big flood since the project completion, with a peak inflow of 70000 m3/s. By controlling the discharge, the maximum flood cut-off reached **30000 m3/s** and **7.3 billion** m3 of water were blocked. In 2010, the TG reservoir had stored 26.6 billion m3 of flood water in total with 7 times regulation.



Navigation and Freight Volume

- After the TGP operation, the shipping conditions of the upper reaches of the Yangtze River were greatly improved, and the 10,000 ton fleet could reach Chongqing directly.
- Navigation safety in the reservoir area was also greatly increased. Statistics show the average annual reduction in accidents was 70% with direct losses decrease of 45%.
- The annual cargo volume of the Three Gorges section increased from 18 million tons before the completion of the project to 142 million tons in 2018.
- The cost of transporting was reduced by one third due to the improvement of the navigation condition.



3 The effects of the Comprehensive Measures

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Power generation

Hydropower station	Designed annual output (TWh)	Actual annual output (TWh)				
		2014	2015	2016	2017	2018
XLD	57.1	-	55.17	61	61.39	62.47
XJB	30.9	-	30.75	33.23	32.84	33.08
TG	88.2	98.82	87.01	93.53	97.61	101.62
GZB	15.7	17.8	18.0	18.3	19.1	18.32
Total	191.9	-	190.93	206.06	210.94	215.48

- As the world's largest water conservancy and hydropower project, TGP produced great social and economic profits. In 2018, the annual power generation of TGHP reached 101.6 TWh.
- It also has great regulation ability of auxiliary services such as Peak shifting and frequency regulation. It can not only supply more than 10 GW during dry season, but coordinating generation with wind and solar generation as well.

3 The effects of the Comprehensive Measures

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Water Replenishment

- The use of the Yangtze River's water resource can be optimized through storing in wet season and using in dry season. Now the Drought Relief is TGP's another primary function along with the flood regulation.
- Taking 2011 as an example, the Yangtze River basin suffered a 100-year frequency drought. Drops in precipitation for the middle and lower reaches of the river were only 40-60% lower than average.
- From 2010 to 2017, the Three Gorges Reservoir replenished 157.2 billion m3 of water to the downstream, effectively guaranteeing the downstream domestic and industrial water supply, and increasing the downstream shipping depth by an average of 0.95 m.

Year	Water Replenishment Days(d)	Replenishment Volume (billion m^3)	Average Additional Depth (m)
2010-2011	164	215	1
2011-2012	150	215	1
2012-2013	169	209	0.8
2013-2014	180	244	1.1
2014-2015	176	243	1.3
2015-2016	170	213	0.7
2016-2017	177	232.9	0.8

3 The effects of the Comprehensive Measures

Ecological Regulation

- Studies show that the regulation of the inflows, the TGP can decrease the sediments and flood-waters diverted to the Dongting Lake in the flood season, thus alleviating dangers to the Dongting Lake, slowing down the speed of sedimentation and extending its life.
- Due to the regulation of the reservoir, downstream discharge during dry season has increased, helping to dilute dirty water, improve the water quality and alleviate pollution.
- After completion of the TG reservoir, the local climate around the reservoir area has improved and agriculture production has increased. Water quality along the middle and lower reaches of the River has also improved during the dry season.
- The influx of salt water into the river delta has also been reduced.
- After repeatedly been proven in the design process, coupled with strict observation for several years following the impoundment, which shows that the reservoir conditions on water quality, sedimentation and seismic activities are better than expected
- The conclusion has been drawn that the TGP is an ecologically friendly project in its essence and that the advantages outweigh the disadvantages.

04 Conclusion
結論

3 Conclusions

1. The TGP and other reservoirs in the trunk or tributaries of upper reaches have formed a cascade of reservoirs, and some others still under constructing reservoirs has laid a foundation for maximizing the use of water resources in the Yangtze river basins.
2. Scientific regulation and control of water resources in the Yangtze river basin, minimizing the flood and drought disasters in the Yangtze river basin, improving the ecological environment and making full use of water resources play an important role in ensuring China's water security and supporting the sustainable development of the Yangtze river economic belt.

THANK YOU!